Studies on the Control of Mealybug (*Dysmicoccus brevipes* (Ckll.)) on Pineapples in Taiwan[1]

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Abstract

Malathion 50% EC and Aldrex-2 were both used for controlling the mealybug (*Dysmicoccus brevipes* Ckll.) and ants respectively. Effective control of mealybug was obtained excellently by dipping the pineapple slips into malathion for 2 minutes at the concentration of 0.1% before planting. There were almost none of mealybugs found for as long as four to five months after the pineapple planted. It is the essential factor that if the pineapples were infested by mass colonies of mealybugs in the earlier months after planting, wilt would occur seriously in the early stage of the growing plants.

Aldrex-2 was diluted into 100 times with water and sprayed at the rate of 4 kgs active ingredient per hectare on the soil surface of pineapple field for every three months. Ants control also gave the constant influence of reducing the mealybug population, however, good results of reducing the ants population were not gained obviously until the beginning of rainy season, during which pineapples were growing more rapidly.

Shorter intervals of malathion applications during the early stage of growing pineapples revealed better results of mealybugs control than that of the treatments of longer intervals of applications.

Introduction

Mealybug (*Dysmicoccus brevipes*) has long been recognized as a main pest of pineapple in Taiwan (9, 10). Since the infestation of mealybugs on pineapple plants for a certain period would probably cause the pineapples to be wilt. This has been demonstrated both in Hawaii and Taiwan (4, 5). The pineapple wilt was considered to be more severe in the southern part of Taiwan, where the pineapple industry was firstly developed by introducing the canning varieties of pineaples from Hawaii and Borneo in 1910's.

Mealybugs' control were conducted by fumigating the slips of pineapple by cyanide gas in the earlier period of plantation. Dr. T. W. Lew (1952, in JCRR) introduced methyl bromide to fumigate the planting metertals using 2 pounds per 1,000 cubic feet, very excellent control of mealybugs was also gained.

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Since there was not any application of mealybug control conducted on the pineapple plants which were remained on the field for as long as twenty months, during this period, subjected to reinfestation of mealybugs. Lee (1953) tried to use several kinds of mineral oil and vegetable oil emulsion to control the mealybugs very excellent in the laboratory. But it was not considered to be of economically used as the field condition of pineapple plantation in Taiwan. Sun et al. (1952) used Folidol E-605 to control the mealybugs by dipping the pineapples slips into the insecticide at the concentration of 0.0233%, excellent results of mealybugs' control were obtained never before, and then a series of trials was conducted by means of spraying and pouring the insecticide into the heart of planting pineapples. Carter (1952) tried some organic phosphates insecticides, e.g., parathion and systox as systemic insecticides to control the mealybugs by spraying. Effect was obtained by contact action, but no evidence of systemic action on the old portions of pineapple was shown in the test.

Several kinds of ants, as described by Takahashi in Taiwan, e. g., ***Pheidologeton diversus*** Jerdon, ***Anopholepis longipes*** Jerdon and ***Camponotus friedae*** var. ***amia*** Ferel, were associated with mealybugs on pineapples. Gerhardt (1953) working in California, found that Aldrin 25% emulsion sprayed on the trunk of valencia orange trees at the rate of 2 pounds active ingredientper 100 gallons of water to control the Argentine ant (***Lridomyrmex humilis***), this spray kept the orange trees free from ants for as long as 3 months.

Materials and methods

Malathion 50% EC. and Aldrex-2 (2 pounds of active ingredients per gallon) were both used in this experiment for controlling mealybugs and ants respectively.

The treatments were that pineapple slips were both dipped and undipped before planting, malathion dilution was then filled into the heart of the pineapples for varying intervals of time, after planting again, there were also different times of applications, e. g., two times of application that were applied in January and July with six months intervals; three times of application, in December, May and October, five months intervals; four times of application, in November, March, July and November, with four months intervals; five times of application, in October, January, April, July and October, with three months intervals; and checks (both dipping and undipping of slips).

The concentrations of malathion for application were used at the rates of 0.1% and 0.05% respectively to each of the treatments that described above. The concentration of malathion for dipping was 0.1%.

Aldrex-2 was diluted into 100 times of water, and sprayed on the soil surface of pineapple field at the rate of 4 kgs. active ingredient per hectare. Sprays were made every three months. All the treatments that described above were divided into ants control and uncontrol respectively.

There should be pointed out that the methods used herein were for the purpose of enhencing the mealybugs to be contacted with insecticide thoroughly. Since the mealybugs disseminated by means of attaching to the butts of pineapple slips in which the mealybugs would be killed by dipping. After planting, the reinfesting mealybug were almost damaging on the butts or the bases of leaves of pineapple, they would also be killed by the insecticide that poured into the heart of pineapple and flowed downward along the whorl of leaves bases in which the mealybugs concealed.

The way of applying malathion on ratoon pineapples was different from that on planting crop. Because the plants of ratoon pineapple stood not so upright as the planting crop did, if the same manner of applying of insecticide, to ratoon pineapples as it was done on planting plants, the insecticide would not reach the butts by flowing out of the base of plant from the slant direction. Therefore, conventional method of spraying was used instead of filling so as to cover the area in which mealybugs might conceal.

The implements which used in this experiment were that a dipping box which used for the pineapple slipping was designed by the former author. The three dimensions of the box is 120×80×45cm. with a capacity of 300 liters and an average of 3,500 to 4,000 pineapple slips would be dipped per hour by four workers (Fig. 4. 5. 6. 7). A cup to which a stick attached was used for filling malathion to the heart of pineapple plants with an amount of 100 cc for each (Fig. 8). Aldrex-2 was applied by means of a knapsack sprayer (Fig. 9).

This experiment was laid out in a randomized block design with 8 x 3m. plots, in each of which pineapples were planted in five single rows with a total of 100 plants, four replications were made in each treatment.

Examination of mealybugs: Examining the populations of mealybug were carried out in February, June, September and December respectively in the planting pineapples. One plant of pineapple was pulled out of every row at random, a total number of 20 plants was taken from each treatment. mealybug colonies were examined by dissecting the plants. In order to evaluate the results of the treatments that might influence the infestation of mealybug on slips, a total of 20 slips in each treatment was examined at random immediately after pineapples were harvested. After the first crop was harvested, the same procedure of examination of mealybug was also emplyed on ratoon pineapples in Mach, June, September and December respectively in the third year.

Examination of ants: Populations of ant density were examined by means of a wire square, the size of which is 50 x 50cm. The wire square was put on both ends of every space between the rows of pineapple with a total number of eight times on each plot. Ants were counted inside the wire square. Examination was carried out every other month after planting.

Examination of pineapple wilt: Since the pineapple wilt was mostly induced by

the infestation of mealybugs, so that the initial symptom of mealybug wilt was usually present about four to five months after planting. Examinations were carried out every month, the beginning of which was about five months after planting. A bamboo stick which was as long as one meter used to stand beside the plant on which the symptoms of wilt were clearly shown.

Results and Discussion

Mealybugs: The occurrence of mealybugs on the planting pineapples showing that the fluctuation of mealybug population density was greatly limited by the weather factors. Since the rainfall concentrated in the period from May to September in the southern part of Taiwan. Heavy rain as well as destructive typhoons always caused the mealybugs unable to establish on the lower portions of pineapple. High humidity was also unfavorable for the development of mealybugs. There were no mealybugs found on the subterranean portion of pineapple during rainy season, however, reinfestation of mealybugs would buildup on the portion below the soil surface as soon as the rainy season was over. This phenomenon that mentioned above was not apparently happened on the ratoon pineapples, because the ratoon pineapples came out from the old stumps of planting crop, the position of the butt of ratoon was higher than that of the planting pineapple. It might avoid the mealybugs being eliminated by soaking into the water that remained in the soil during rainy season. In addition, the leaves of ratoon pineapples were of flourish that would, in part, shelter the mealybugs from the attacking of heavy rainfall.

The majority of mealybugs were damaging on the bases of planting pineapple leaves in comparison with that of roots. The movement of mealybugs colonies from stumps to suckers were verv slow as it is shown in table 3.

Effectiveness of the treatments indicating that dipping of planting materials in all of the treatments were better than that of undipping. Especially, in the period about four months after planting, there were almost not any mealybug found in the treatments that the slips had been dipped. As a result, mealybug wilt also presented rare in this group of treatments.

Ants control indicated much more significant effect of reducing the populations of mealybug than any other treatments in this experiment. It was not of great different between the two groups of treatments in reducing the number of mealybugs in the earlier period of growing stage, but it showed more conspicuous results in the treatments of ant control as the time lasting longer. In both checks (dipping and undipping of slips), control of ants showed better results of reducing mealybugs population than that of the treatments which had had five applications of malathion. It might be due to the fact that malathion was of short residual insecticide. There, again, the treatments of ants control showed less infestation of mealybugs on the slips after harvesting than that of any other treatments as shown in Fig. 3.

There were no evidence of differences of effect among the different intervals of application which were associated with ants control. But the results showing that the shorter intervals of application, the better of mealybug control were obtained in the treatments which were not associated with ants control.

Ants: The population of ants was not high during the earlier period about seven months after the pineapples planted, meanwhile, there were not great different of ant populations between the two groups of treatments. But differences of ant populations density showing between the two groups of treatments became conspicuously as soon as the beginning of the rainy season. There was a tendency that the ants population density became higher as the pineapples growing more thrivingly, but with an exception of low temperature in January.

Pineapple wilt: Wilt was examined every month from May about seven months after the pineapples planted. It is obviously that the higher population density of mealybugs in the earlier growing stage of pineapple, the severe wilt occurred earlier and being lasted longer period of time, on the other hand, the less number of mealybugs that infested on the pineapples in some other treatments for the same period of duration, but the wilt occurred not so seriously and appeared about several months later. It seemed clearly that the less number of mealybugs were inadquate to produce sufficient toxin to cause wilt within short period of time. This would be what the advantage that we took for controlling the mealybugs by reducing the number of their infestation on pineapples. In most of the treatments, the peaks of wilt occurred more or less in the period from November to January in spite of the densities of the mealybug population. During this period, most of the pineapples were differentiated or in the early blossom stage, after which severe wilt was rarely seen in those treatments which have had good results of mealybug control.

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Table 1. Population of mealybugs on the planting pineapples

Treatments of slips	Malathion EC Concentrations %	Malathion EC Times of applications	Control of ants	1955 February Ground under	1955 February Ground Above	June Ground under	June Ground Above	September Ground under	September Ground Above	December Ground under	December Ground Above	Total Ground under	Total Ground Above
Dipped	0.1	2	Controlled						0.05		0.05		0.10
			Uncontrolled								12.25		12.25
		3	Controlled						0.05				0.05
			Uncontrolled						7.00		0.80		7.80
		4	Controlled				0.10		1.95				2.05
			Uncontrolled				0.05		1.45				1.50
		5	Controlled				0.10		0.05				0.15
			Uncontrolled								0.10		0.10
	0.05	2	Controllod				0.50						0.50
			Uncontrolled			0.25	14.85		1.55	0.90	70.70	1.15	87.10
		3	Controllod				0.10		0.10				0.20
			Uncontrolled			0.15	1.60		0.30		1.75	0.15	3.65
		4	Controllod				6.50						6.50
			Uncontrolled				0.30		1.25	0.10	0.70	0.10	2.25
		5	Controllod			0.75	16.40				0.10	0.75	16.50
			Uncontrolled				0.05						0.05
	Check (Untreated)		Controlled	0.05	2.60		1.70		0.05		0.15	0.05	4.50
			Uncontrolled		4.40		9.85		13.15	1.55	55.55	1.55	82.95
Undippsd	0.1	2	Controlled	0.10	0.25		3.80					0.10	4.05
			Uncontrolled	15.75	4.40	1.15	43.40		12.30	10.90	110.75	27.80	170.85
		3	Controlled		0.05		0.80		0.25				1.10
			Uncontrolled		0.10				0.05				0.15
		4	Controlled				0.25						0.25
			Uncontrolled		0.05		6.65		0.95		19.40		27.05
		5	Controlled										
			Uncontrolled						0.05				0.05
	0.05	2	Controlled		1.20	0.15	3.10	1.05	0.15		0.40	1.20	4.85
			Uncontrolled		0.65		37.55		4.40	0.05	32.40	0.05	75.00
		3	Controlled		0.10	0.15	2.45					0.15	2.55
			Uncontrolled				2.55		3.90		5.85		12.30
		4	Controlled				0.05						0.05
			Uncontrolled			0.75	18.50		0.45	0.40	0.25	1.15	19.20
		5	Controlled				0.15				0.05		0.20
			Uncontrolled				0.25		1.20		4.00		5.45
	Check (Untreated)		Controlled		5.00		4.65		0.60	0.15	4.25	0.15	14.50
			Uncontrolled		4.75	4.60	213.40	0.10	35.20	2.30	76.45	7.00	329.80

Table 2. Populations of mealybug on ratoon pineapple plants

Treatments of slips	Malathion EC Concentrations %	Times of application	1956 March Ants Controlled	March Ants uncontrolled	June Ants Controlled	June Ants uncontrolled	September Ants Controlled	September Ants uncontrolled	December Ants Controlled	December Ants uncontrolled	Average
Dipped	0.1	2	2.40	5.05	0.55	48.65	0.35	8.70	1.50	99.95	20.89
		3	3.55	21.85	1.30	19.10	0.85	47.85	0.40	53.00	18.49
		4	0.25	6.95	5.85	25.05	2.00	14.05	0.60	51.50	13.28
		5	0	3.05	3.10	31.75	0.35	11.85	0.80	26.70	9.70
	0.05	2	0.15	4.30	2.55	28.60	1.40	33.05	3.65	185.25	32.37
		3	5.95	4.75	3.40	44.30	2.05	116.10	2.30	134.85	39.21
		4	6.90	11.60	6.45	36.55	0.45	28.35	0.60	34.10	15.63
		5	9.05	1.45	1.35	90.20	0	46.20	0.75	67.65	27.08
	Check (Untreated)		2.40	115.65	4.35	203.60	1.85	121.85	3.75	146.20	74.96
Undipped	0.1	2	0.70	20.70	2.35	80.60	0.80	135.05	8.75	117.05	45.75
		3	3.05	16.30	22.25	108.55	0.55	114.00	3.75	84.55	44.13
		4	1.40	16.15	6.30	63.50	0.20	13.30	0.10	69.25	21.27
		5	0.35	10.25	0.50	14.10	0.40	26.15	0.40	38.80	11.37
	0.05	2	12.05	8.00	3.80	55.40	1.70	74.85	3.30	77.75	29.61
		3	0.60	5.55	1.55	52.80	0.90	60.65	3.10	46.25	21.43
		4	0.40	27.90	31.90	59.80	0.95	31.55	1.25	55.80	26.19
		5	1.45	4.90	0.40	59.10	0.70	38.60	0	25.80	16.37
	Check (Untreated)		2.40	144.65	1.90	206.85	0.55	278.45	1.05	108.50	93.04

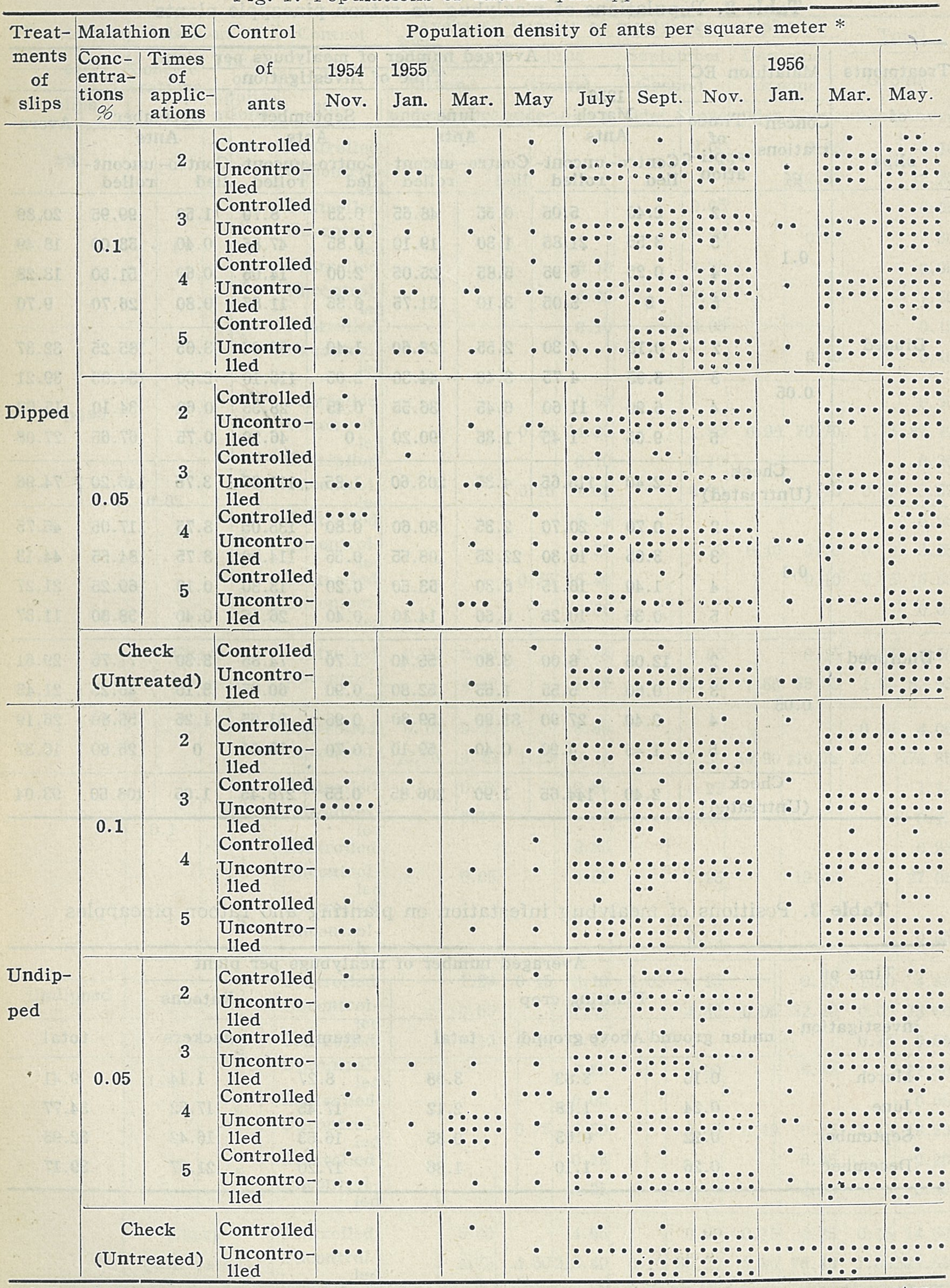
(Column header: Averged number of mealybugs per plant — Time of investigation)

Table 3. Positions of mealybug infestation on planting and ratoon pineapples

Time of investigation	Planting crop: under ground	Planting crop: Above ground	Planting crop: total	Ratoons: stumps	Ratoons: suckers	Ratoons: total
March	0.15	3.83	3.98	8.27	1.14	9.41
June	0.24	1.88	2.12	17.45	17.32	34.77
September	0.22	0.63	0.85	16.53	16.42	32.95
December	0.26	1.10	1.36	17.20	21.97	39.17

(Column header: Averaged number of mealybugs per plant)

Fig. 1. Populations of ants in pineapple field



* Population of ant is indiiated by dot.atr. One dot represents 0.1~0.50 ants per square meter

Fig. 2. Occurrence of pineapple wilt on planting crop

Treatments of slips	Malathion EC: Concentrations %	Malathion EC: Times of applications	Control of ants.	Percentage of pineapple wilt *: 1955 Mar.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1956 Jan.	Feb.	Mar.	April	May	June
Dipped	0.1	2	Controlled							•		••					
			Uncontrolled					•		••	••	••					
		3	Controlled							•	••	•					
			Uncontrolled						•	•••	•••••	••	•				•
		4	Controlled						••	••	••	••••	••	••			
			Uncontrolled							••	••	•••					••
		5	Controlled							••	••	•••	••		•		
			Uncontrolled			••				••	••	•••	•				
	0.52	2	Controlled			•					••	••					
			Uncontrolled	••			•	•••	•••	•••	•	••••	••		•		••
		3	Controlled			••			•	•••	•••••	•••••••	••	•••			
			Uncontrolled				•	•		•		•	•	•			
		4	Controlled	••					•	••	•	••••	••				
			Uncontrolled	••						•		•				•	••
		5	Controlled	••		•			•			••	••	•			
			Uncontrolled								•	•		•			•
	Check (Untreated)		Controlled	•	•	•			•	••	•••	••••	•	•			
			Uncontrolled	•••			•	•••	••••••	•••••••••	••••	••	••	•	•	•	••
Undipped	0.1	2	Controlled	•	•	••				•	••	•					
			Uncontrolled	••			••••	•••••	•••••	•••••••	•••••	•••••••	••	••	•		•••••
		3	Controlled	•		••			•		••	•	••				•
			Uncontrolled						••	•••	••	••••	••				
		4	Controlled	••		•	•			•	••	•••••	•	••			
			Uncontrolled	••				••	••	•	••	••	••				
		5	Controlled		•	•				••	•••	••••	••	•			
			Uncontrolled			•				••	••						•
	0.05	2	Controlled	•			••	•	•	••	•••••	••		•			
			Uncontrolled	••				•••	•••	••	••	•••					••
		3	Controlled	••						••	•	••	•		•		
			Uncontrolled		•	•		•	••••	•••••••••	••••	••	••				•
		4	Controlled	•		•					••	••	•				
			Uncontrolled	•		•		••	••	••••	••	••	••	•••			••
		5	Controlled	•						•••	••	•••					
			Uncontrolled	•	•				•	••		•••	•	•			
	Check (Untreated)		Controlled	••	•			•	••	•	••••	••••	•	•			•
			Uncontrolled		••	•••••	••••	•••••	••••••••••••	•••••••••	•••••••••	••••••	••				••••••

* Percentage of wilt is indicated by dot. One dot represents 0.01～0.50% of wilt

Fig. 3. Infestation of mealybugs on pineappe slips

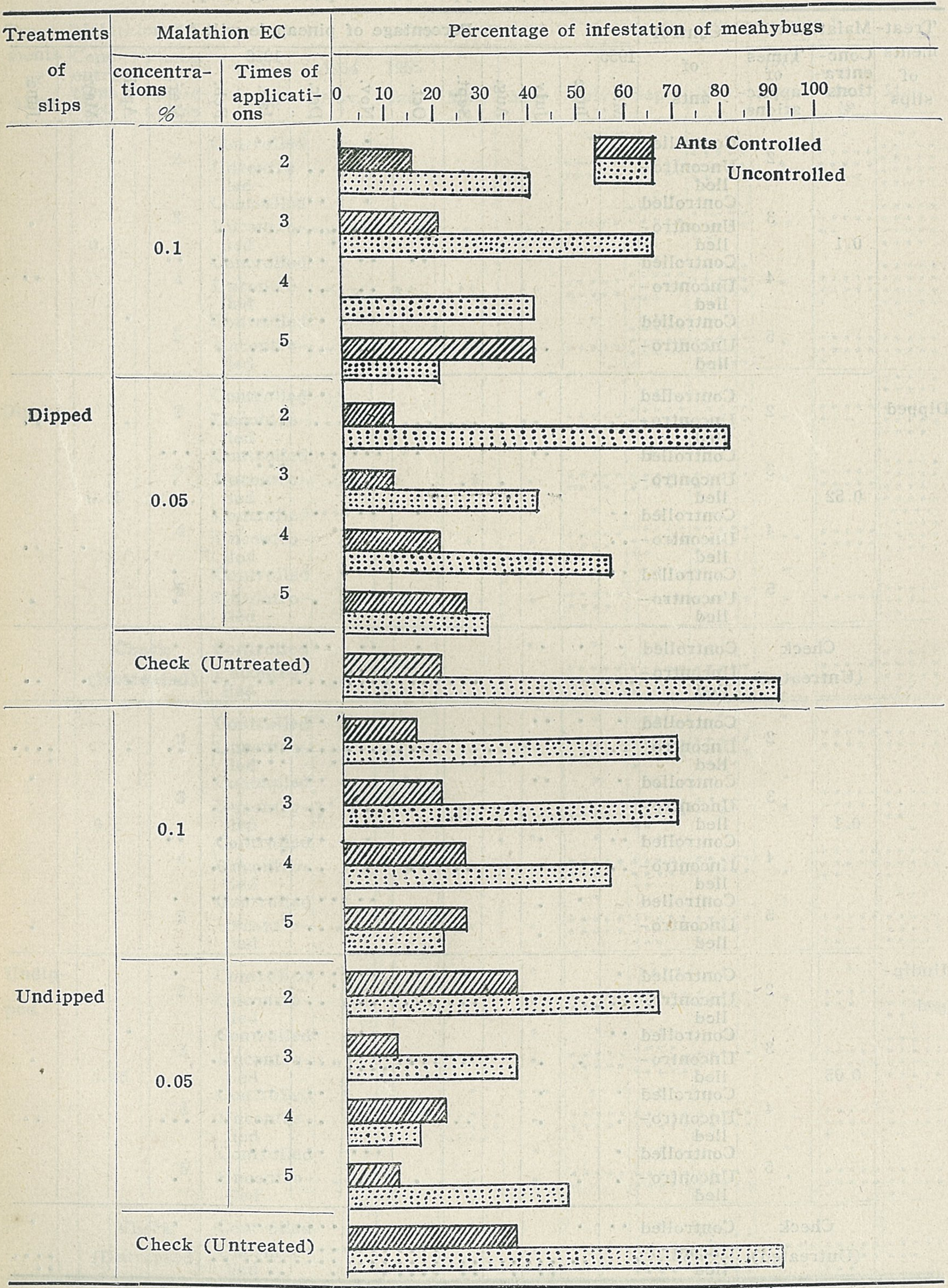


Fig. 4.

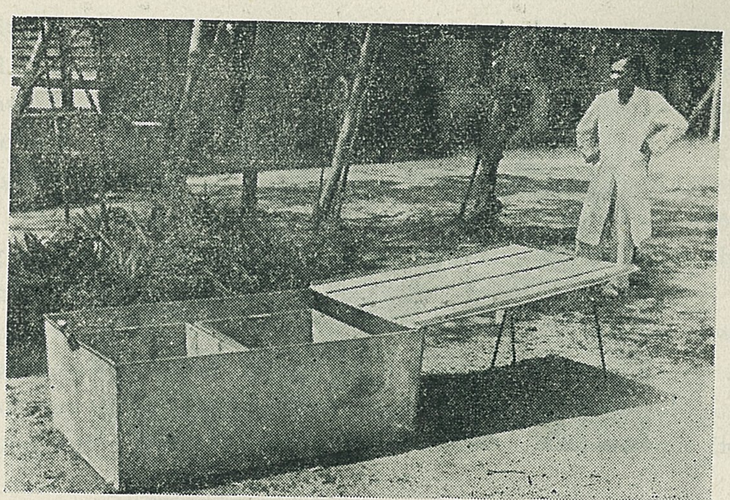


Fig. 5.

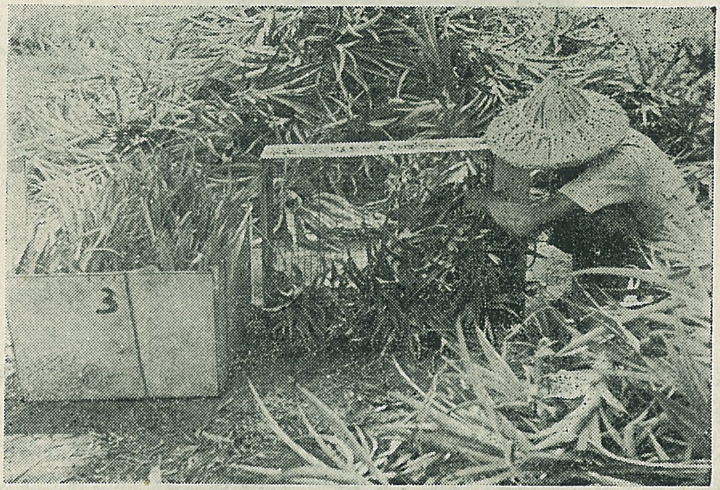


Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 4. A dipping box with three pairs of small boxes for loading pineapple slips. The lid on which is for putting the slips which have been dipped.

Fig. 5. The small box with trellis wire bottom, showing pineapple slips being put into the box.

Fig. 6. Showing the operation of dipping. No. 1 and 3 of the small boxes were put beside the dipping box waiting for dipping. No. 2 was taken from the dipping box and put on the lid upside down for draining out the remaining insecticide back into the dipping box.

Fig. 7. Pineapple slips which had been dipped were put upside down near the pineapple field for about 5 days before planting.

Fig. 8. A cup of insecticide being poured into the heart of pineapple.

Fig. 9. Aldrex-2 dilution was sprayed on the soil surface of pineapple field.

鳳梨粉介殼虫（*Dysmicoccus brevipes* (Ckll.)）防治試驗

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中文摘要

一、本試驗歷時三年完成，對於粉介殼蟲之防治，由各處理之調查結果，在鳳梨定植後八個月內，以浸苗之效果最爲顯著，以後由於田間粉介殼蟲之日漸傳佈，其成效顯因時間之延長而漸趨低落，但在定植後八個月左右粉介殼蟲蟲口密度之高低，對新植株萎凋病發病程度，有顯著之決定作用。

二、防蟻之效果在最初七，八個月左右，並無顯著之成效，但自此以後若繼續施藥，其效果爲諸處理中最顯著者，且隨時間之延長其效益彰。

三、灌藥次數多寡，其效果雖亦有差異，惟在不防蟻區較爲顯著，一般以灌藥三次並加防蟻，其效果與單獨灌藥五次者並無顯著差異。至殺蟲劑之濃度以馬拉松（Malathion EC）之有效成份 0.1%較0.05%爲優。

四、粉介殼蟲之蟲口密度，雖因受氣候之影響而有高峯現象，但鳳梨之生長情形亦可左右其密度。例如在鳳梨之新植株上，粉介殼蟲之棲息部位僅局限根部及靠近地面之基部，所以在雨期其蟲口密度易受降雨及土壤水分之影響而急劇下降，至雨期終止後其密度復漸增高。但在鳳梨之宿根株，粉介殼蟲之密度在雨期雖略受影響，但不若新植株上所受影響之甚，其原因可能係粉介殼蟲在宿根株上棲息之位置離地面較高，而鳳梨植株亦較高大，植株之葉相互交錯，使粉介殼蟲有較多隱蔽之處，而免受雨水冲失或浸死之患。

五、螞蟻週年發生之消長，受氣溫之影響較爲顯著，即在高溫時其密度甚高，在一，二月低溫期則趨下降，但爲時甚暫。惟螞蟻發生密度受鳳梨生育之影響亦至鉅，即在鳳梨定植後六，七個月以內，因係在乾旱期，鳳梨發育遲緩，土面爲植株所遮蓋者甚少，而多曝露於陽光之下，所以螞蟻之密度甚低，但雨期來臨之後，鳳梨發育旺盛，葉部將大部份之土面遮蓋，因此螞蟻之密度即隨之而增高。

六、鳳梨萎凋病之發生嚴重與否，與定植後初期植株上附着之粉介殼蟲蟲數多寡有密切之關係。凡有經浸苗，而灌藥及防蟻均提前在定植後約八個月內處理有三次者，則萎凋病之發生必較輕微或延後，而發病期亦較短暫；反之，萎凋病之發生必較早而嚴重，發病期亦隨之增長。

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